

What is claimed is:

(1) A system for recovering potential energy from a  
pressurized gas fuel supply which is used to power a fuel  
cell within a vehicle, said system comprising:

5 a fuel tank which stores pressurized gas;

a first conduit system which selectively and fluidly  
couples said fuel tank to said fuel cell, effective to  
allow said pressurized gas to be selectively communicated  
to said fuel cell;

10 an expander including a turbine which is disposed  
within said first conduit system and which is selectively  
and rotatably driven by said pressurized gas, effective  
to generate torque and lower the pressure of said  
pressurized gas which is communicated to said fuel cell;

15 a second conduit system which selectively and  
fluidly couples said fuel cell to a source of air,  
effective to allow said air to be selectively  
communicated to said fuel cell;

a compressor which is disposed within said second  
20 conduit system and which is selectively coupled to and  
driven by said expander, said compressor being effective  
to pressurize said air which is communicated to said fuel  
cell; and

an electric machine which is operatively coupled to  
25 said expander and to said compressor, said electric  
machine being effective to selectively convert torque

generated by said expander into electrical power, and to selectively convert electrical power into mechanical torque for rotatably driving said compressor.

(2) The system of claim 1 further comprising a source of  
5 electrical power which is selectively coupled to said electric machine.

(3) The system of claim 2 further comprising a bypass valve which is effective to cause said pressurized gas to selectively bypass said expander.

10 (4) The system of claim 3 further comprising:

at least one sensor that is effective to measure at least one vehicle operating attribute and to generate a signal representing said measured vehicle operating attribute; and

15 a controller which is communicatively coupled to said bypass valve and to said at least one sensor, said controller being effective to receive said signal and to selectively control said bypass valve based upon the value of said signal.

20 (5) The system of claim 4 further comprising:

a switching module which is electrically and communicatively coupled to said controller and which is electrically coupled to a plurality of electrical components;

25 wherein said controller selectively controls said switching module, effective to selectively transfer said

generated power to one or more of said plurality of electrical components.

(6) The system of claim 5 wherein said controller is further effective to selectively and electrically connect  
5 said electric machine to said source of electrical power by use of said switching module.

(7) The system of claim 1 further comprising:  
at least one pressure-reducing regulator which is disposed within said first conduit system.

10 (8) A system for supplying pressurized hydrogen gas and air to a fuel cell within a vehicle, said system comprising:

a fuel tank which stores said pressurized hydrogen gas;

15 a first conduit system which selectively and fluidly couples said fuel tank to said fuel cell, effective to allow said pressurized hydrogen gas to be selectively communicated to said fuel cell;

20 a motor/generator for selectively converting torque into electrical power, and for selectively converting electrical power into mechanical torque;

a source of electrical power which is selectively connected to said motor/generator and which selectively provides electrical power to said motor/generator;

25 an expander which is disposed within said first conduit system, which is operatively coupled to said

motor/generator, and which is selectively and rotatably driven by said pressurized hydrogen gas, effective to lower the pressure of said hydrogen gas which is communicated to said fuel cell and to cause said  
5 generator to produce electrical power;

a second conduit system which fluidly couples said fuel cell to a source of air, effective to allow said air to be selectively communicated to said fuel cell;

a compressor which is disposed within said second  
10 conduit system, which is operatively coupled to said motor/generator, and which is selectively and operatively coupled to said expander, said compressor being selectively and rotatably driven by said expander and by said motor/generator and being effective to pressurize  
15 said air within said second conduit system; and

a clutch which selectively connects and disconnects said expander and said compressor.

(9) The system of claim 8 further comprising:

a bypass valve which is disposed within said first  
20 conduit system and which is effective to cause said pressurized hydrogen gas to selectively bypass said expander; and

a controller which is communicatively connected to said bypass valve and which selectively actuates said  
25 bypass valve, effective to cause said pressurized hydrogen gas to selectively bypass said expander.

10) The system of claim 9 wherein said controller is further connected to said motor/generator and which is effective to cause said motor/generator to drive said compressor when said pressurized hydrogen gas bypasses  
5 said expander.

(11) The system of claim 10 further comprising:

a plurality of sensors which are effective to measure vehicle operating attributes and to generate signals representing said measured vehicle operating  
10 attributes; and

wherein said controller is communicatively coupled to said plurality of sensors and is effective to receive said signals and to selectively actuate said bypass valve based upon the value of said signals.

15 (12) The system of claim 10 wherein said compressor comprises a turbine.

(13) The system of claim 10 wherein said expander comprises a turbine.

(14) A method for recovering potential energy stored  
20 within a pressurized gas used to power a fuel cell within a vehicle, said method comprising the steps of:

providing a first conduit system for transferring said pressurized gas to said fuel cell;

providing an expander;

25 operatively disposing said expander within said first conduit system;

providing a motor/generator for producing electrical power from torque and for producing torque from electrical power;

providing a second conduit system for transferring  
5 air to said fuel cell;

providing a compressor;

operatively disposing said compressor within second conduit system;

operatively connecting said expander and said  
10 compressor to said motor/generator;

selectively connecting said expander and said compressor; and

channeling said pressurized gas through said expander, effective to rotatably drive said expander,  
15 thereby selectively driving said compressor and selectively causing said motor/generator to produce electrical power.

(15) The method of claim 14 further comprising the steps of:

20 measuring a vehicle operating attribute;

selectively causing said pressurized gas to bypass said expander, based upon said measured vehicle operating attribute.

(16) The method of claim 15 further comprising the steps  
25 of:

providing a source of electrical power; and

connecting said source of electrical power to said motor/generator when said pressurized gas bypasses said expander, effective to cause said motor/generator to produce torque and rotatably drive said compressor.

5 (17) The method of claim 16 further comprising the step of:

disconnecting said compressor from said expander when said pressurized gas bypasses said expander.

10 (18) The method of claim 16 wherein said vehicle operating attribute comprises a pressure of said gas in a certain location within said conduit system.

(19) The method of claim 16 wherein said source of electrical power comprises a battery.

15 (20) The method of claim 19 further comprising the step of:

delivering said produced electrical power to said battery effective to recharge said battery.

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